

IN THE CLAIMS

Please amend the claims as follows:

Claim 1 (Previously Presented): A noise suppression apparatus, which can remove an inutile noise from an input signal comprising an object signal and the inutile noise mixed therein to output the object signal, said apparatus comprising:

a time/frequency conversion unit which converts the input signal into an amplitude spectrum and a phase spectrum by frequency-analyzing the input signal in each frame;

a noise-likeness analyzing unit which receives the input signal including the object signal and the noise mixed therein, and which performs linear predictive analysis to obtain linear predictive coefficients used to generate a low pass residual signal, and which performs correlation analysis on the low pass residual signal, and which determines the noise-likeness of the input signal frame;

a noise amplitude spectrum calculation unit which calculates the noise amplitude spectrum from the input amplitude spectrum of the frame on the basis of the result of said noise-likeness analyzing unit;

a spectrum correction gain calculation unit which calculates a noise amplitude spectrum correction gain, on the basis of the input amplitude spectrum, the noise amplitude spectrum and a first predetermined coefficient, and which calculates a noise removal spectrum correction gain, on the basis of the input amplitude spectrum, the noise amplitude spectrum and a second predetermined coefficient;

a spectrum deduction unit which calculates a product of the noise amplitude spectrum and the noise amplitude spectrum correction gain, which is sent from said spectrum correction gain calculation unit, then deducts the product from the input amplitude spectrum so as to output a first noise removal spectrum;

a spectrum suppression unit which calculates a product of the first noise removal spectrum and the noise removal spectrum correction gain so as to output a second noise removal spectrum; and

a frequency/time conversion unit which converts the second noise removal spectrum to a time domain signal.

Claim 2 (Original): The noise suppression apparatus according to claim 1 wherein said spectrum correction gain calculation unit comprises,

a spectrum correction gain limiting value calculation unit which calculates spectrum correction gain limiting values, on the basis of the input amplitude spectrum and the noise amplitude spectrum, which spectrum correction gain limiting values limit the correction gains of the noise amplitude spectrum and the noise removal spectrum; and

a correction gain calculation unit which calculates a noise amplitude spectrum correction gain and a noise removal spectrum correction gain, on the basis of the input amplitude spectrum, the noise amplitude spectrum and the spectrum correction gain limiting value, which noise amplitude spectrum correction gain corrects the value of the amplitude of the noise amplitude spectrum in each frequency component, and which noise removal spectrum correction gain corrects the value of the amplitude of the noise removal spectrum for each frequency component.

Claim 3 (Original): The noise suppression apparatus according to claim 2 further comprising a spectrum band dividing unit which divides the input amplitude spectrum sent from said time/frequency conversion unit into a plurality of frequency bands and calculates the average spectrum of each frequency band, and divides the noise amplitude spectrum from

said noise amplitude spectrum calculation unit into a plurality of frequency bands and calculates the average spectrum of each frequency band,

wherein said spectrum correction gain limiting value calculation unit and said correction gain calculation unit, that form said spectrum correction gain calculation unit, calculate the spectrum amplitude limiting value, noise amplitude spectrum correction gain and the noise removal spectrum correction gain, on the basis of average spectrum of each frequency band of the input amplitude spectrum and the noise amplitude spectrum, which are outputs of said spectrum band dividing unit, in place of the input amplitude spectrum and the noise amplitude spectrum.

Claim 4 (Original): The noise suppression apparatus according to claim 1 further comprising,

a spectrum smoothing coefficient calculation unit which calculates smoothing coefficients of the input amplitude spectrum and the noise amplitude spectrum, according to the state of the input signal; and

a spectrum smoothing unit which smoothes the input amplitude spectrum and the noise amplitude spectrum in the time base and in the frequency base, on the basis of the spectrum smoothing coefficients, and outputs a smoothed input amplitude spectrum and a smoothed noise amplitude spectrum,

wherein said spectrum correction gain calculation unit comprises a correction gain calculation unit which calculates a noise amplitude spectrum correction gain and a noise removal spectrum correction gain, on the basis of the smoothed input amplitude spectrum and the smoothed noise amplitude spectrum, which noise amplitude spectrum correction gain is used for correcting the value of the amplitude for each frequency component of the noise

amplitude spectrum, and which noise removal spectrum correction gain is used for correcting the value of the amplitude of the noise removal spectrum.

Claim 5 (Original): The noise suppression apparatus according to claim 4 further comprising a spectrum band dividing unit which divides the input amplitude spectrum sent from said time/frequency conversion unit into a plurality of frequency bands and calculates the average spectrum of each frequency band, and divides the noise amplitude spectrum sent from said noise amplitude spectrum calculation unit and calculates the average spectrum of each frequency band,

wherein said spectrum smoothing coefficient calculation unit calculates smoothing coefficients for the input amplitude spectrum and the noise amplitude spectrum, on the basis of the input amplitude average spectrum of each frequency band and the noise amplitude average spectrum of each frequency band, which are sent from said spectrum band dividing unit, and

wherein said spectrum smoothing unit calculates the smoothed input amplitude spectrum and the smoothed noise amplitude spectrum, on the basis of the input amplitude average spectrum of each frequency band and the noise amplitude average spectrum of each frequency band, which are sent from said spectrum band dividing unit.

Claim 6 (Original): The noise suppression apparatus according to claim 2 further comprising,

a spectrum smoothing coefficient calculation unit which calculates the smoothing coefficients for the input amplitude spectrum and the noise amplitude spectrum, according to the state of the input signal; and

a spectrum smoothing unit which smoothes the input amplitude spectrum and the noise amplitude spectrum in the time base and in the frequency base, using the smoothing coefficients of the spectra,

wherein said correction gain calculation unit calculates the noise amplitude spectrum correction gain and the noise removal spectrum correction gain, on the basis of the smoothed input amplitude spectrum, smoothed noise amplitude spectrum and the spectrum correction gain limiting value, in place of the input amplitude spectrum and the noise amplitude spectrum.

Claim 7 (Original): The noise suppression apparatus according to claim 6 further comprising a spectrum band dividing unit which divides the input amplitude spectrum sent from said time/frequency conversion unit into a plurality of frequency bands and calculates the average spectrum of each frequency band, and divides the noise amplitude spectrum sent from said noise amplitude spectrum calculation unit into a plurality of frequency bands and calculates the average spectrum of each frequency band,

wherein said spectrum smoothing coefficient calculation unit, said spectrum smoothing unit, said spectrum correction gain limiting value calculation unit and said correction gain calculation unit use the output from said spectrum band dividing unit in place of the input amplitude spectrum and the noise amplitude spectrum, for carrying out their function.

Claim 8 (Original): The noise suppression apparatus according to claim 4 wherein said spectrum smoothing coefficient calculation unit calculates the smoothing coefficients for the input amplitude spectrum and the noise amplitude spectrum, according to the result of the noise likeness analyzing unit.

Claim 9 (Original): The noise suppression apparatus according to claim 6 wherein said spectrum smoothing coefficient calculation unit calculates the smoothing coefficients for the input amplitude spectrum and the noise amplitude spectrum, according to the result of the noise likeness analyzing unit.

Claim 10 (Previously Presented): A noise suppression apparatus, comprising:

- a unit for determining noise amplitude spectrum of an input signal;
- a unit for analyzing noise-likeness of an input signal including an object signal and noise mixed therein, the analyzing unit performing linear predictive analysis to obtain linear predictive coefficients used to generate a low pass residual signal, and performing correlation analysis on the low pass residual signal, and determining the noise-likeness of the input signal;
- a unit for calculating a noise amplitude spectrum gain based on an input amplitude spectrum of the input signal and the noise amplitude spectrum, correcting the noise amplitude spectrum gain with a predetermined first coefficient to obtain a noise amplitude spectrum correction gain, and calculating a noise removal spectrum correction gain based on the input amplitude spectrum of the input signal and the noise amplitude spectrum; and
- a unit for performing, with respect to the input amplitude spectrum of the input signal, spectrum subtraction based on the noise amplitude spectrum correction gain and spectrum suppression based on the noise removal spectrum correction gain to thereby remove the noise component from the input signal, wherein

the determining unit determines the noise amplitude spectrum from the noise-likeness of the input signal.

Claim 11 (Previously Presented): A noise suppression apparatus, comprising:

a unit for determining noise amplitude spectrum of an input signal;

a unit for analyzing noise-likeness of an input signal including an object signal and noise mixed therein, the analyzing unit performing linear predictive analysis to obtain linear predictive coefficients used to generate a low pass residual signal, and performing correlation analysis on the low pass residual signal, and determining the noise-likeness of the input signal;

a unit for calculating a noise amplitude spectrum gain based on an input amplitude spectrum of the input signal and the noise amplitude spectrum, calculating a noise removal spectrum correction gain based on the input amplitude spectrum of the input signal and the noise amplitude spectrum, and correcting the noise removal spectrum correction gain using a predetermined second coefficient to obtain a noise removed spectrum correction gain;

a unit for performing, with respect to the input amplitude spectrum of the input signal, spectrum subtraction based on the noise amplitude spectrum gain and spectrum suppression based on the noise removal spectrum correction gain to thereby remove the noise component from the input signal, wherein

the determining unit determines the noise amplitude spectrum from the noise-likeness of the input signal.

Claim 12 (Currently Amended): A noise suppression apparatus, which can remove an inutile noise from an input signal comprising an object signal and the inutile noise mixed therein to output the object signal, said apparatus comprising:

a time/frequency conversion unit which converts the input signal into an amplitude spectrum and a phase spectrum by frequency-analyzing the input signal in each frame;

a noise-likeness analyzing unit which receives the input signal including the object signal and the noise mixed therein, and which performs linear predictive analysis to obtain linear predictive coefficients used to generate a low pass residual signal, and which performs correlation analysis on the low pass residual signal, and which determines the noise-likeness of the input signal frame ~~The noise suppression apparatus according to claim 1,~~ wherein the correlation analysis generates a position peak value, and the noise-likeness analyzing unit includes an updating rate coefficient determining unit that calculates noise likeness based on the positive peak value[[]];

a noise amplitude spectrum calculation unit which calculates the noise amplitude spectrum from the input amplitude spectrum of the frame on the basis of the result of said noise-likeness analyzing unit;

a spectrum correction gain calculation unit which calculates a noise amplitude spectrum correction gain, on the basis of the input amplitude spectrum, the noise amplitude spectrum and a first predetermined coefficient, and which calculates a noise removal spectrum correction gain, on the basis of the input amplitude spectrum, the noise amplitude spectrum and a second predetermined coefficient;

a spectrum deduction unit which calculates a product of the noise amplitude spectrum and the noise amplitude spectrum correction gain, which is sent from said spectrum correction gain calculation unit, then deducts the product from the input amplitude spectrum so as to output a first noise removal spectrum;

a spectrum suppression unit which calculates a product of the first noise removal spectrum and the noise removal spectrum correction gain so as to output a second noise removal spectrum; and

a frequency/time conversion unit which converts the second noise removal spectrum to a time domain signal.



Claim 13 (Previously Presented): The noise suppression apparatus according to claim 12, wherein the updating rate coefficient determining unit calculates the noise likeness further based on a power of the low pass residual signal for a present frame and a power all over a frequency region of the object signal of the present frame.

Claim 14 (Currently Amended): A noise suppression apparatus, comprising:  
a unit for determining noise amplitude spectrum of an input signal;  
a unit for analyzing noise-likeness of an input signal including an object signal and noise mixed therein, the analyzing unit performing linear predictive analysis to obtain linear predictive coefficients used to generate a low pass residual signal, and performing correlation analysis on the low pass residual signal, and determining the noise-likeness of the input signal ~~The noise suppression apparatus according to claim 10,~~ wherein the correlation analysis generates a position peak value, and the unit for analyzing noise-likeness includes an updating rate coefficient determining unit that calculates noise likeness based on the positive peak value[.];

a unit for calculating a noise amplitude spectrum gain based on an input amplitude spectrum of the input signal and the noise amplitude spectrum, correcting the noise amplitude spectrum gain with a predetermined first coefficient to obtain a noise amplitude spectrum correction gain, and calculating a noise removal spectrum correction gain based on the input amplitude spectrum of the input signal and the noise amplitude spectrum; and

a unit for performing, with respect to the input amplitude spectrum of the input signal, spectrum subtraction based on the noise amplitude spectrum correction gain and spectrum

suppression based on the noise removal spectrum correction gain to thereby remove the noise component from the input signal, wherein

the determining unit determines the noise amplitude spectrum from the noise-likeness of the input signal.

Claim 15 (Previously Presented): The noise suppression apparatus according to claim 14, wherein the updating rate coefficient determining unit calculates the noise likeness further based on a power of the low pass residual signal for a present frame and a power all over a frequency region of the object signal of the present frame.

Claim 16 (Currently Amended): A noise suppression apparatus, comprising:  
a unit for determining noise amplitude spectrum of an input signal;  
a unit for analyzing noise-likeness of an input signal including an object signal and noise mixed therein, the analyzing unit performing linear predictive analysis to obtain linear predictive coefficients used to generate a low pass residual signal, and performing correlation analysis on the low pass residual signal, and determining the noise-likeness of the input signal ~~The noise suppression apparatus according to claim 11,~~ wherein the correlation analysis generates a position peak value, and the unit for analyzing noise-likeness includes an updating rate coefficient determining unit that calculates noise likeness based on the positive peak value[.];

a unit for calculating a noise amplitude spectrum gain based on an input amplitude spectrum of the input signal and the noise amplitude spectrum, calculating a noise removal spectrum correction gain based on the input amplitude spectrum of the input signal and the noise amplitude spectrum, and correcting the noise removal spectrum correction gain using a predetermined second coefficient to obtain a noise removed spectrum correction gain;

a unit for performing, with respect to the input amplitude spectrum of the input signal, spectrum subtraction based on the noise amplitude spectrum gain and spectrum suppression based on the noise removal spectrum correction gain to thereby remove the noise component from the input signal, wherein  
the determining unit determines the noise amplitude spectrum from the noise-likeness of the input signal.

Claim 17 (Previously Presented): The noise suppression apparatus according to claim 16, wherein the updating rate coefficient determining unit calculates the noise likeness further based on a power of the low pass residual signal for a present frame and a power all over a frequency region of the object signal of the present frame.